Utilizing PRISMA Hyperspectral Satellite Data for Geological Mapping and Mineral Exploration

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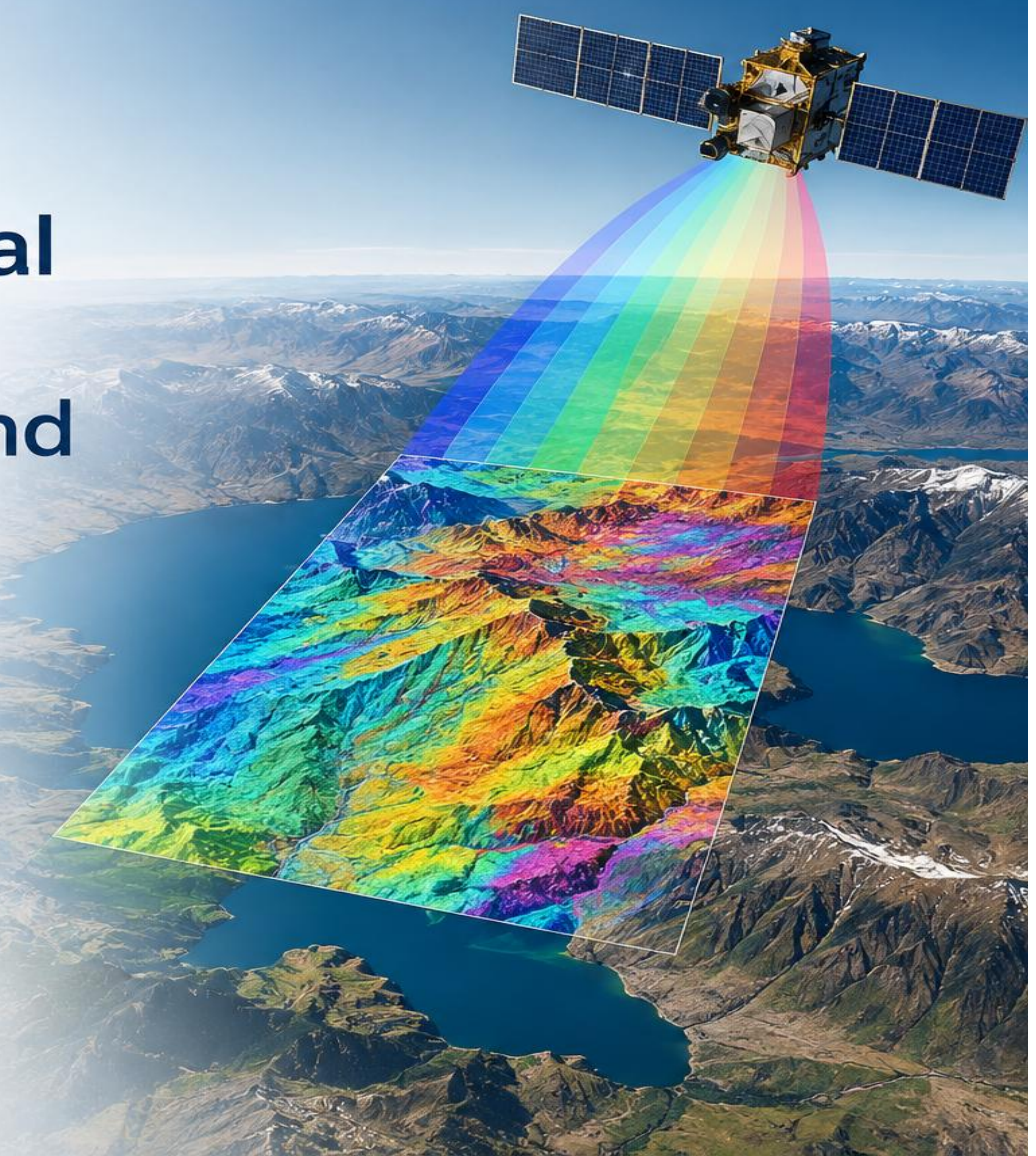

PRISMA

GEOLOGICAL MAPPING

MINERAL EXPLORATION

HYPERSPECTRAL DATA

OVERVIEW

1. Introduction
2. Data used & Methodology
3-Reference-Based mapping
4-Training-Based Mapping
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1. Introduction

- ✓ PRISMA hyperspectral imagery provides detailed spectral information for mapping minerals and hydrothermal alteration. This study evaluates its application to mineral exploration in two Mongolian case-study areas.

Objectives

- Map selected mineral indicators
- Delineate hydrothermal alteration zones
- Compare spectral results with geological information

2. Data used & Methodology

PRISMA	Specifications
Spatial Resolution	30 m
Swath Width	30 km
Spectral Channels	238 unique channels, 400 nm -2505 nm
	VNIR (66 channels, 400 nm – 1010 nm),
	SWIR (171 channels, 920 nm – 2505 nm)
	Pan (1 channel, 400 nm - 700 nm)
Spectral Bandwidth	12 nm (nominal)
Radiometric resolution	12 bits

Case study 1	Case study 2
USGS reference spectra	Training samples or ROIs
SAM spectral matching	Training-based classification
Band-ratio analysis	Mineral and lithological mapping
Candidate spectral anomalies	Classified mineral/lithological zones

1. Spectral Angle Mapper (SAM)

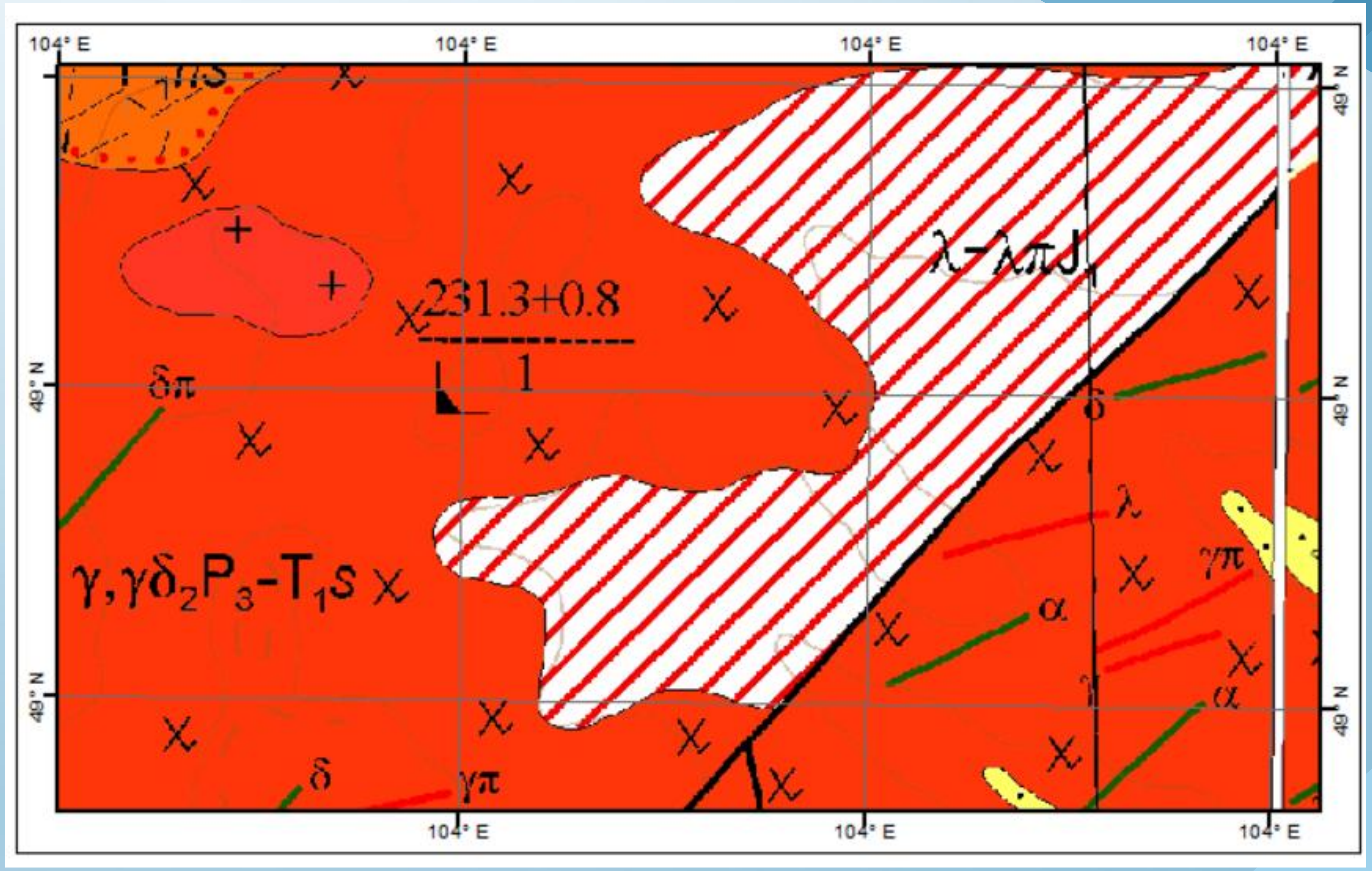
- Comparison with reference spectra
- USGS Spectral Library used as spectral reference
- Mineral classification based on spectral similarity

2. Band Ratio Analysis

- Enhancement of diagnostic absorption features
- Identification of alteration zones
- Lithological discrimination

3. Reference-based mineral mapping and band-ratio analysis – Case Study 1

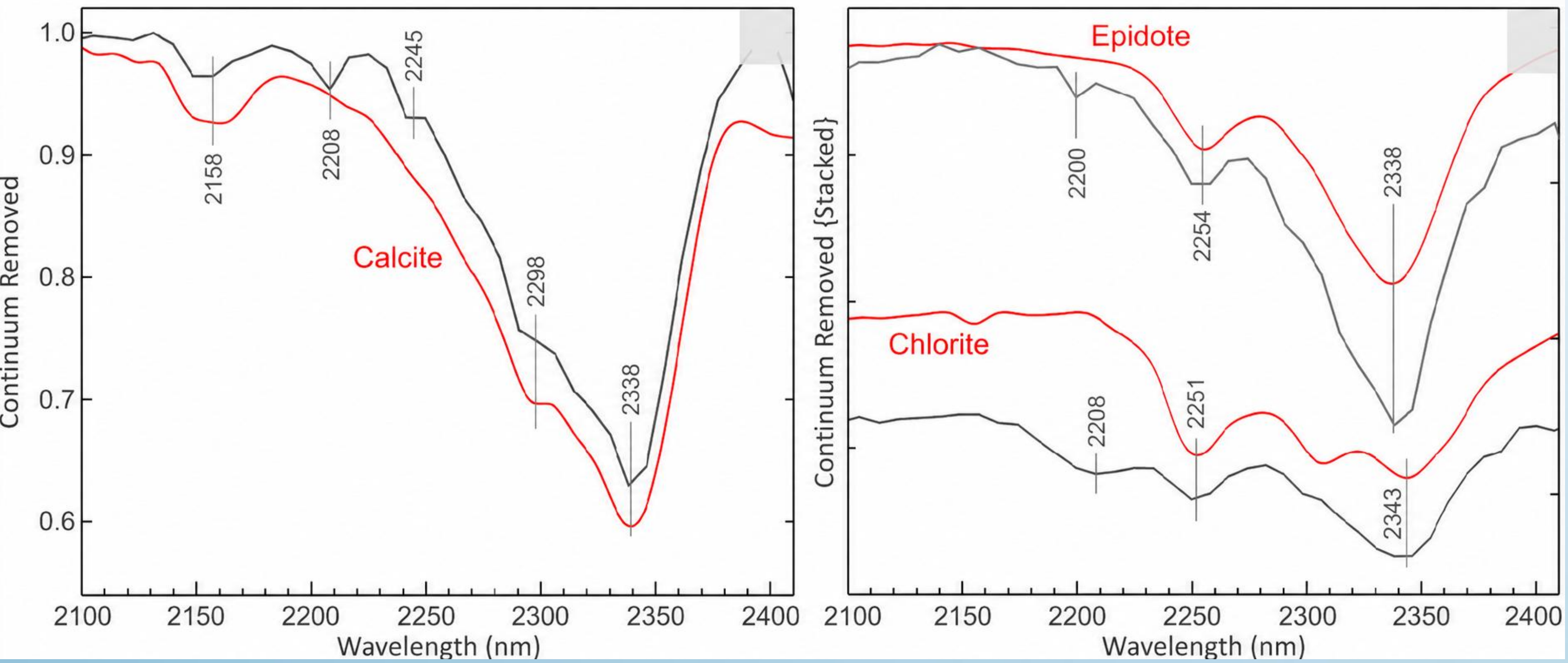
- The project area is situated in Orkhon Province, northern Mongolia.
- Geological Setting:
  The project area is predominantly underlain by intrusive igneous rocks. Several lithological contacts, faults, and narrow intrusive bodies are observed across the area. The northeastern part is characterized by a distinct geological contact, while structural features locally cut the intrusive rocks. Overall, the area shows an intrusive-dominated geological setting.



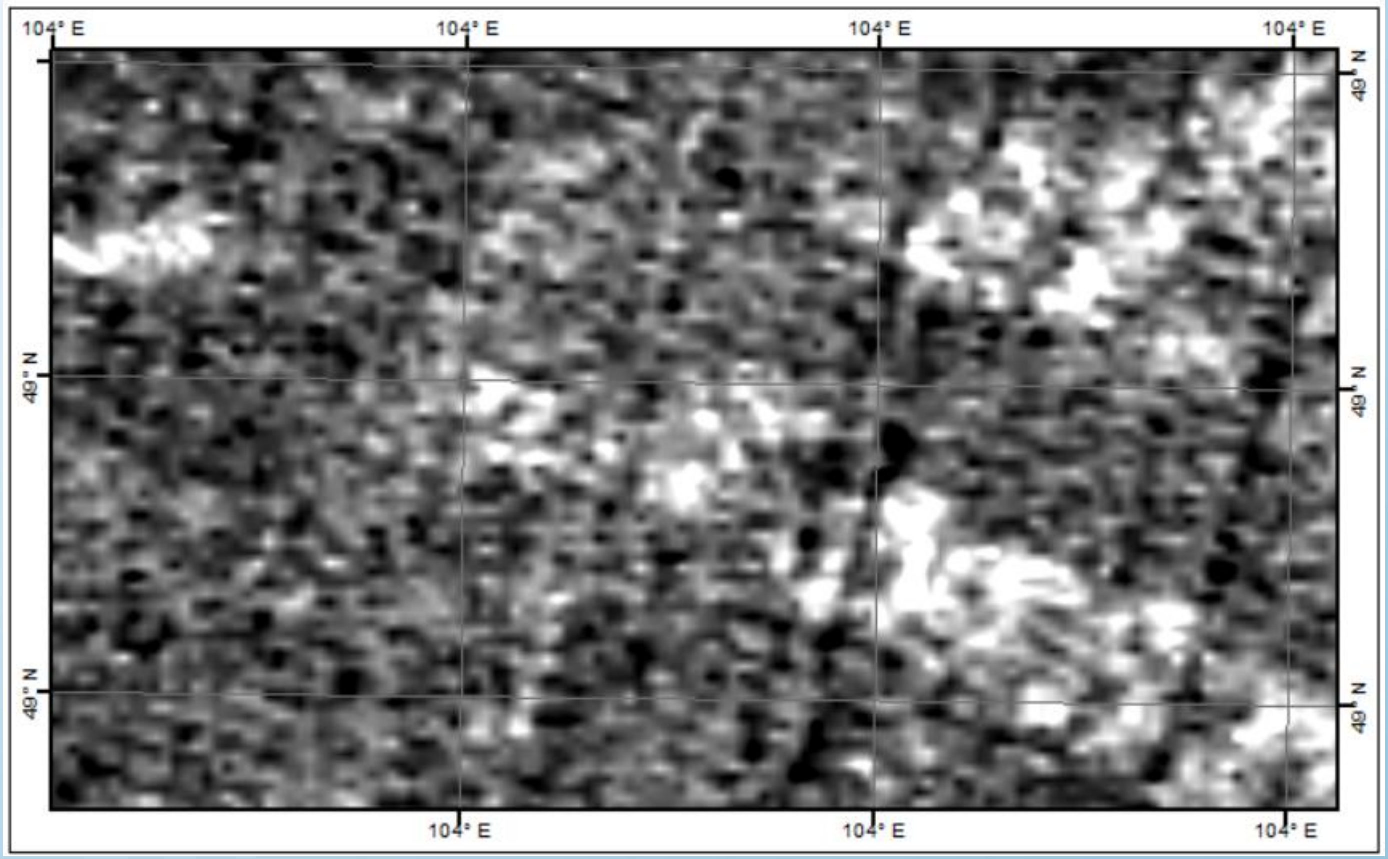
Mineral Abbreviations
Chl — Chlorite, Cal — Calcite, Ep — Epidote
Msc — Muscovite, Ser — Sericite, Ill — Illite
Mon — Montmorillonite, Kln — Kaolinite

Results

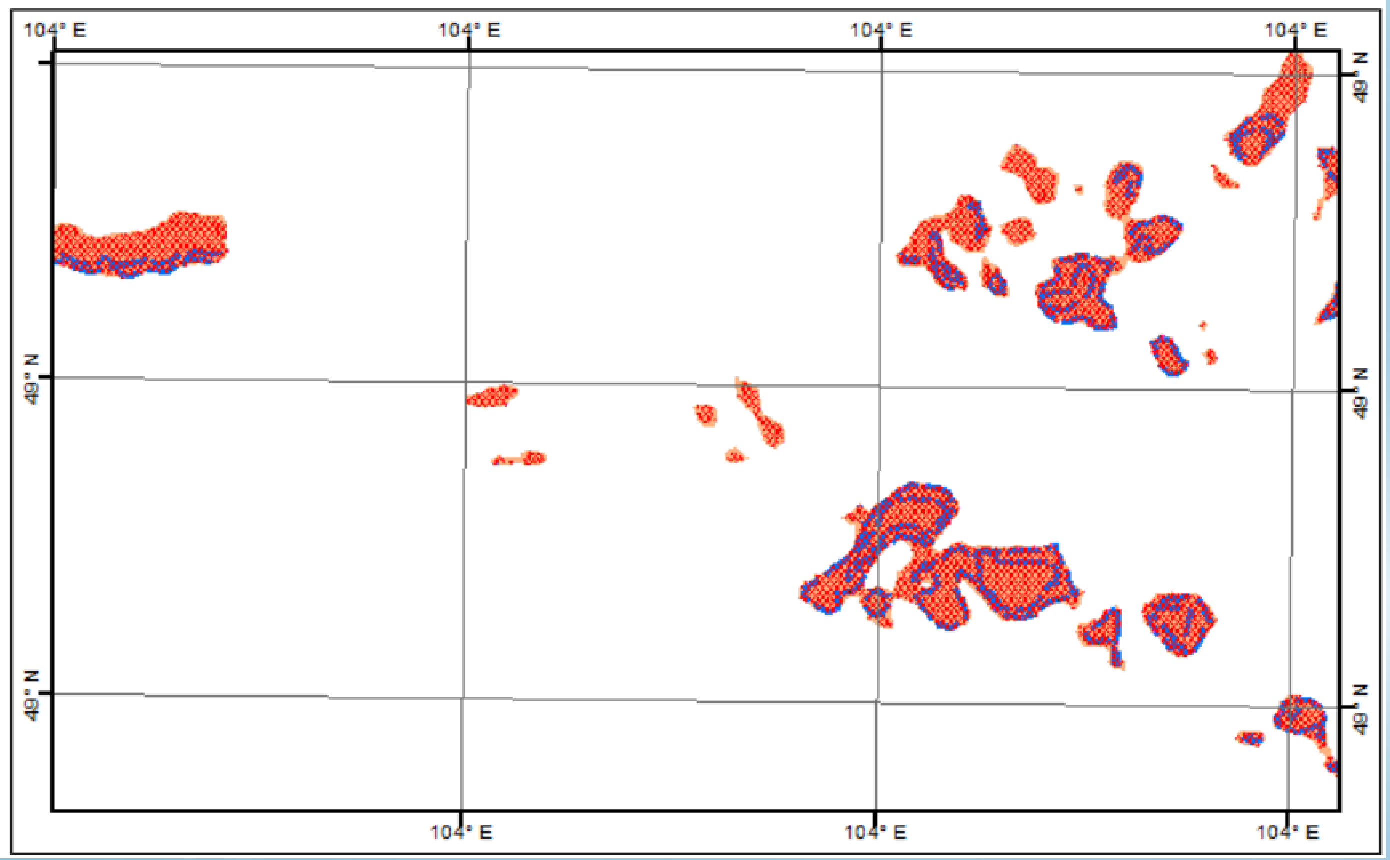
PROPYLITIC ALTERATION



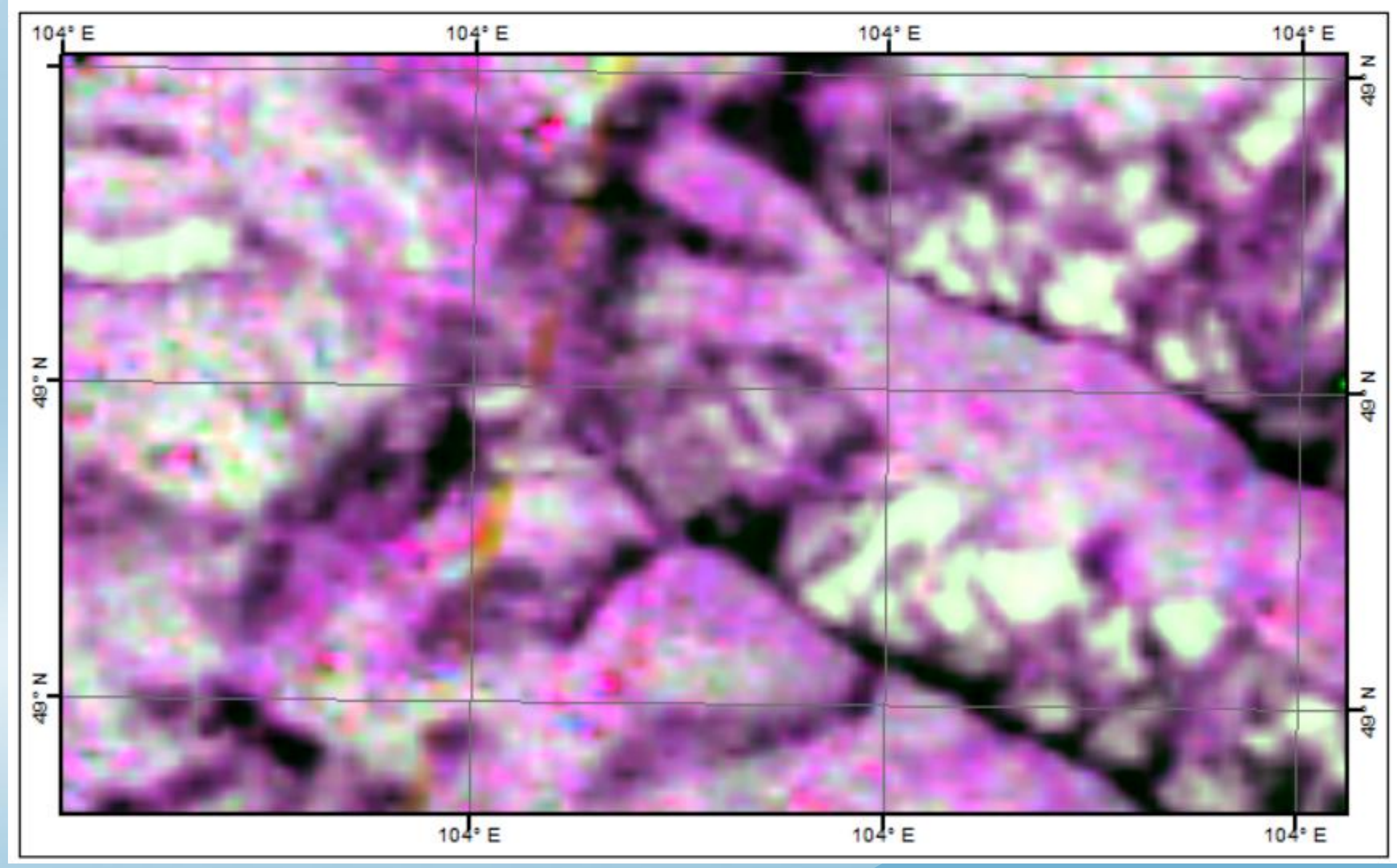
Spectral profile (Kokaly et al., 2017)



Band Ratio Mapping

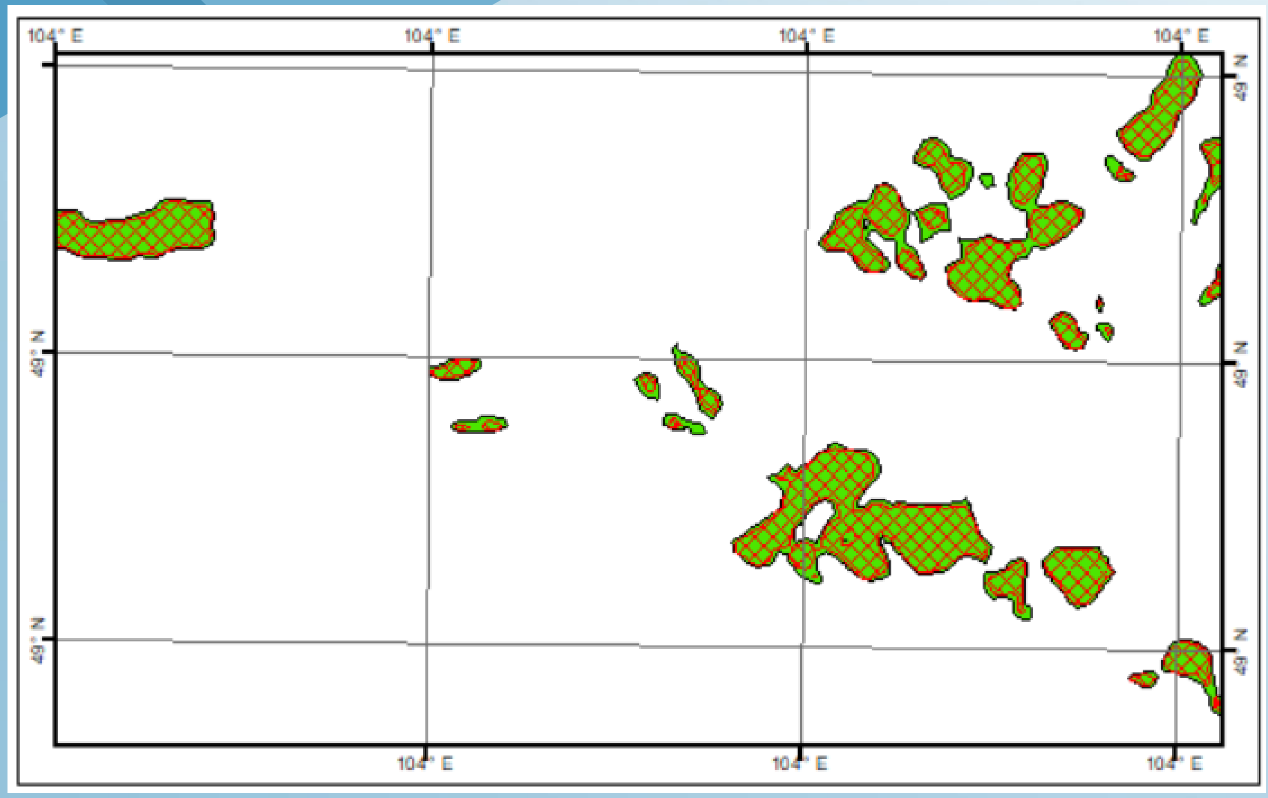


SAM-based Mapping



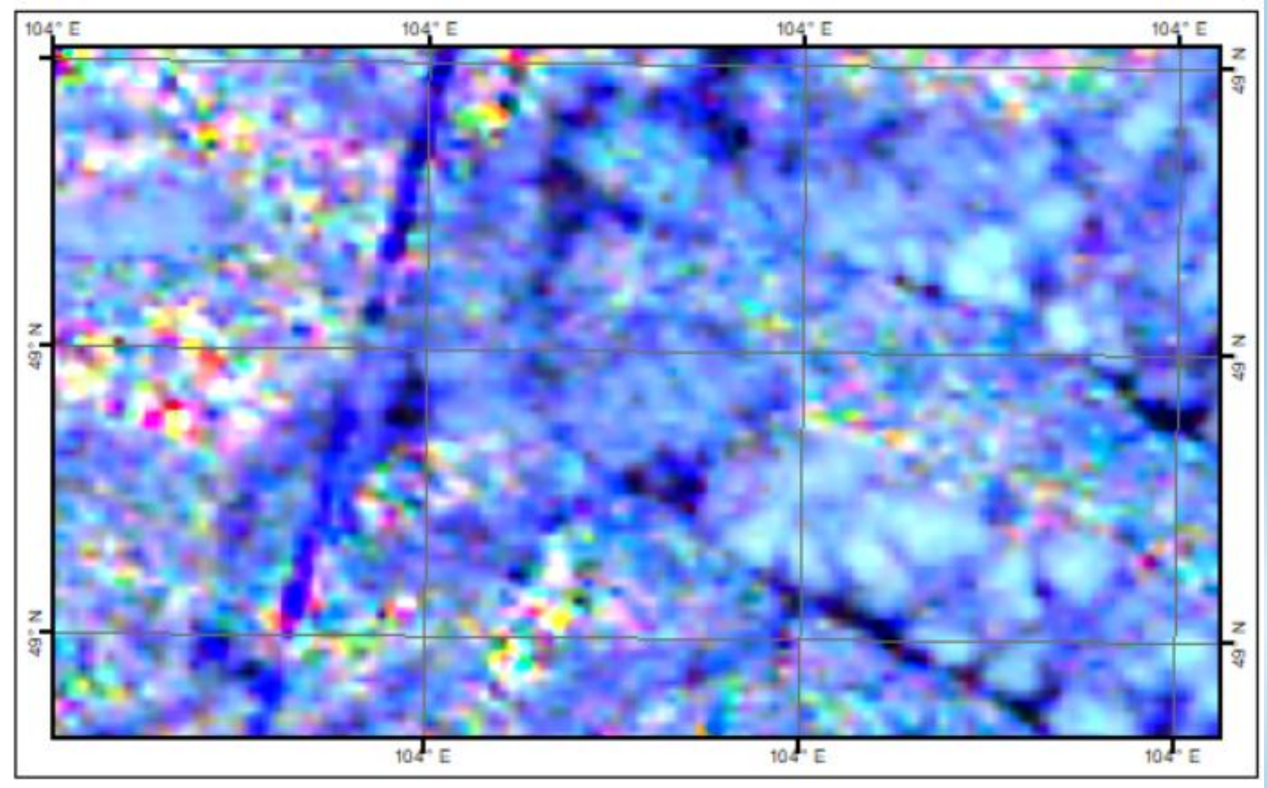
Mineral-Based Mapping (Chl–Cal–Ep)

PHYLLIC ALTERATION

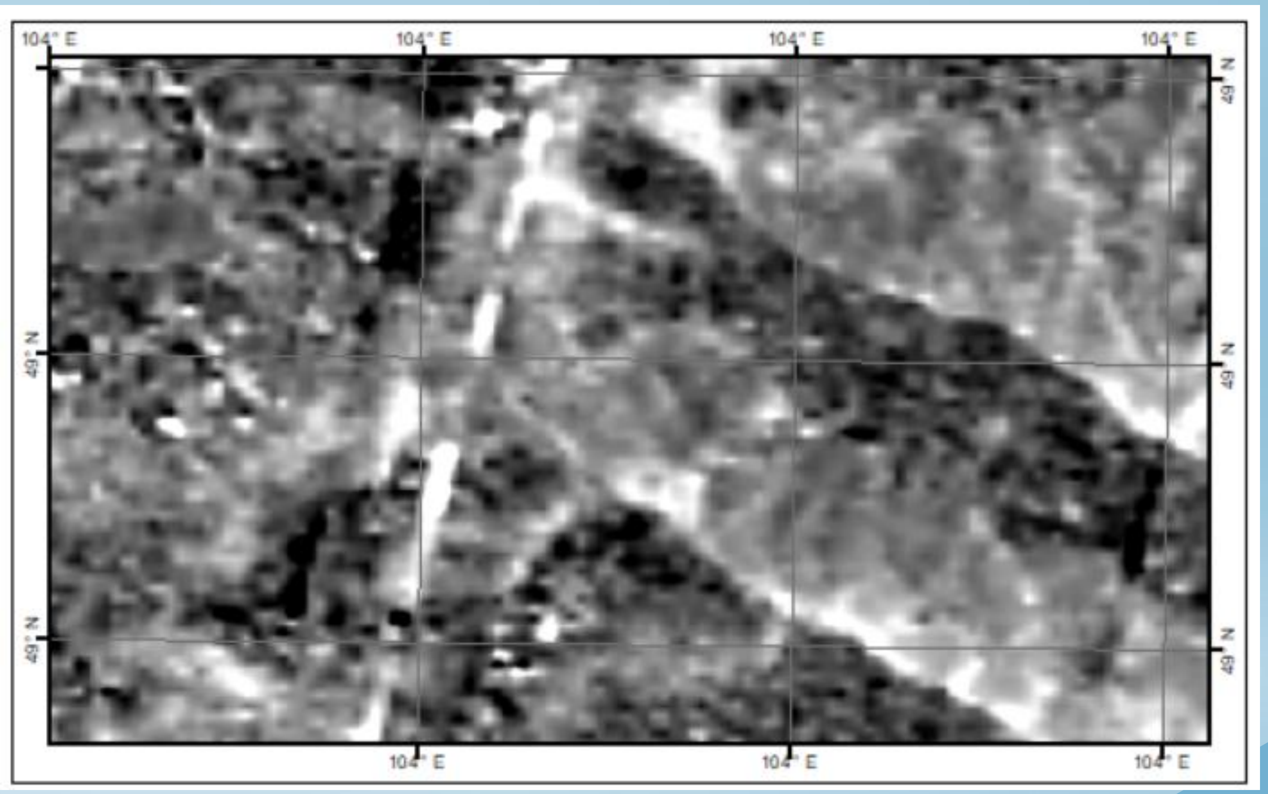


SAM-Based Mapping

Wavelength	Spectral feature	Interpretation
~1,400 nm	OH-related absorption	Muscovite/sericite
~1,900 nm	H_2O-related absorption	Water / hydroxyl contribution
~2,190–2,220 nm	**Strong Al–OH absorption**	**Muscovite / sericite**
~2,300–2,350 nm	Weaker absorption features	White mica composition / mineral mixture
>2,400 nm	Reduced spectral reliability	Possible mixture effects

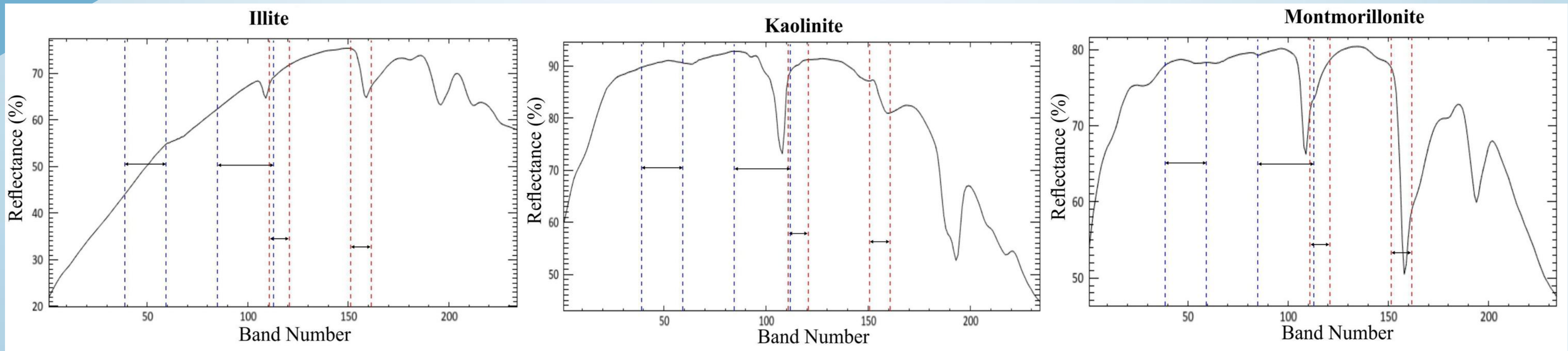


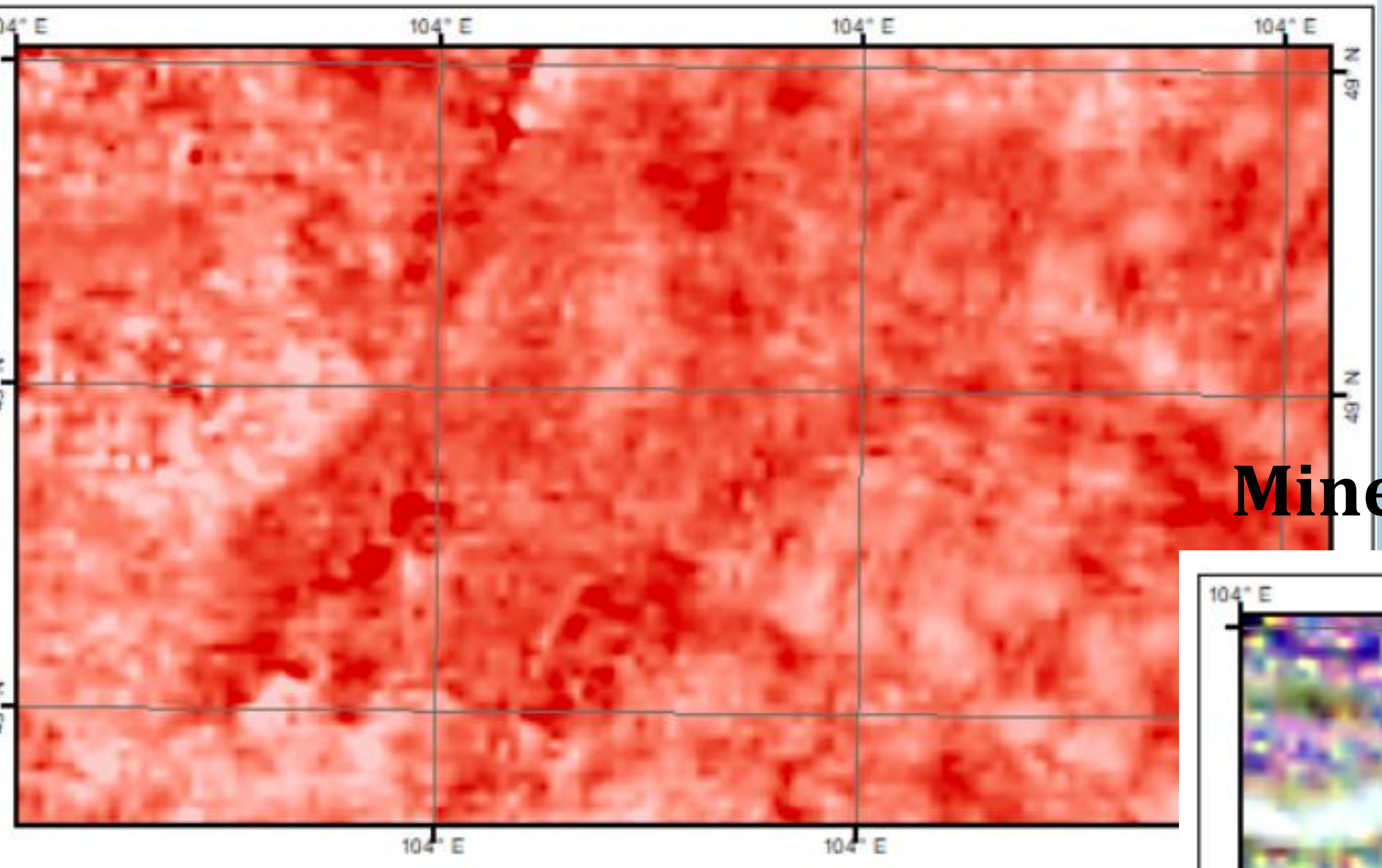
Mineral-Assemblage Mapping (Msc–Ser–Qtz)



Band Ratio Mapping

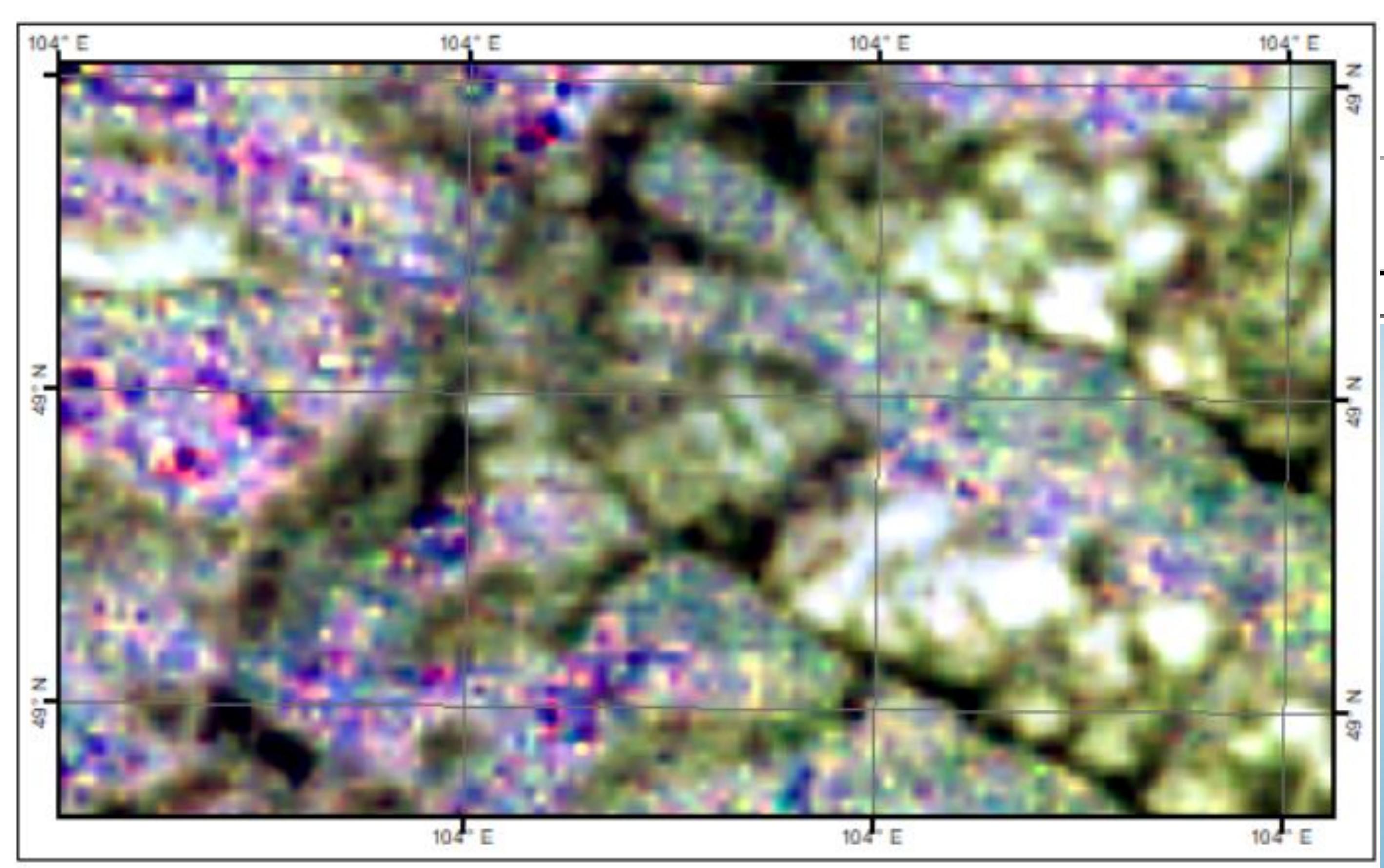
ARGILLIC ALTERATION

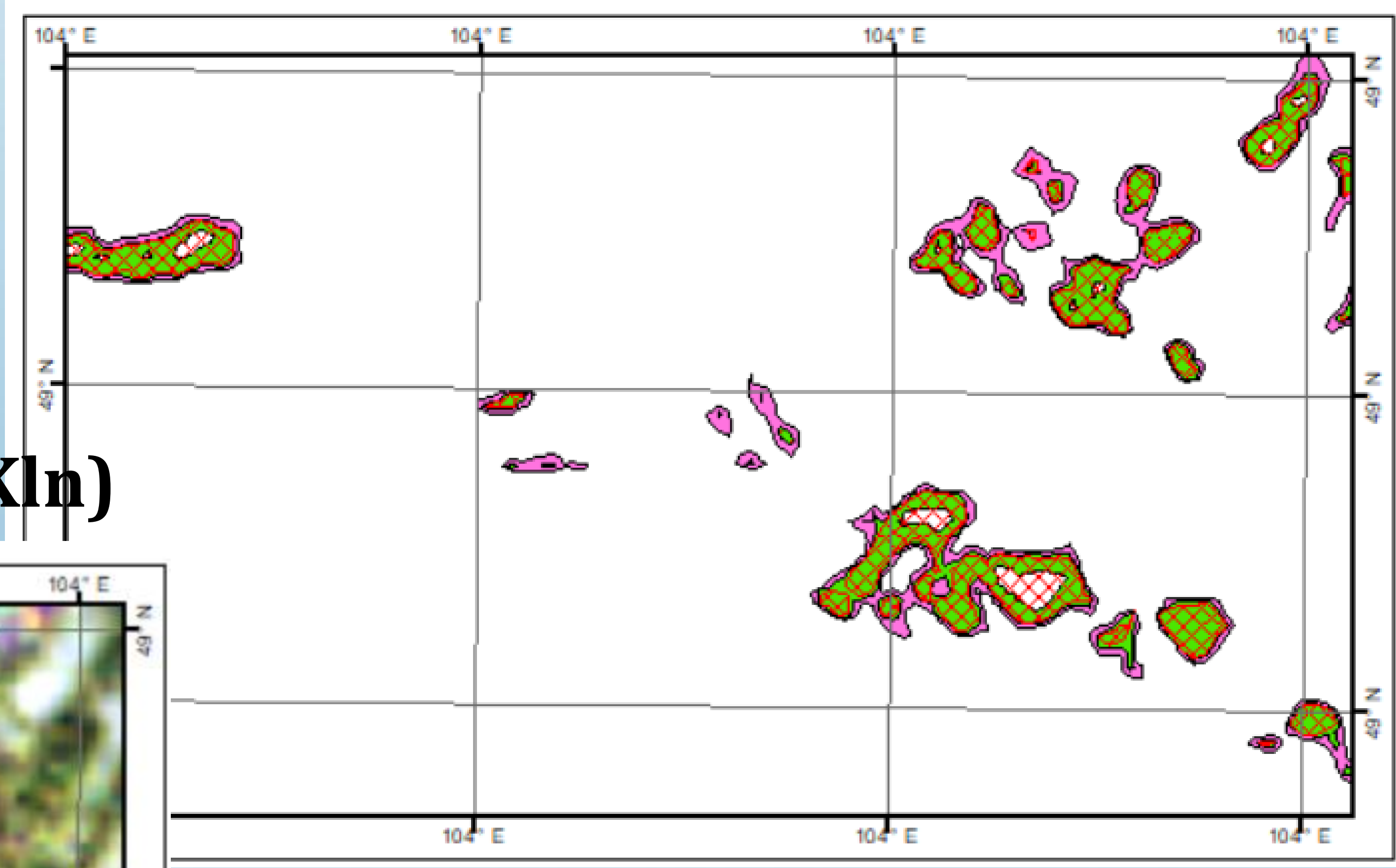




Band Ratio Map

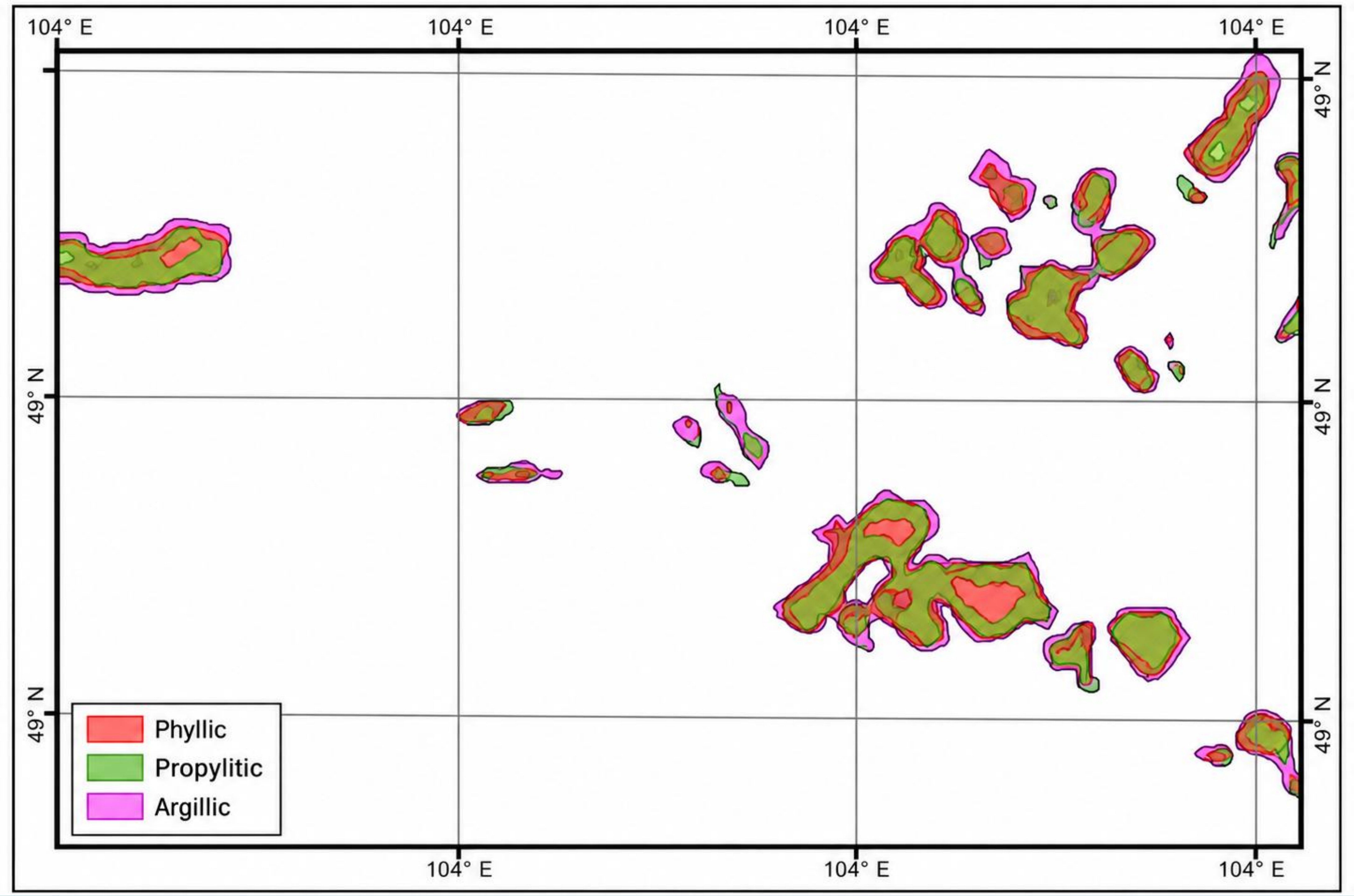
Mineral-Based Mapping (Ill–Mon–Kln)





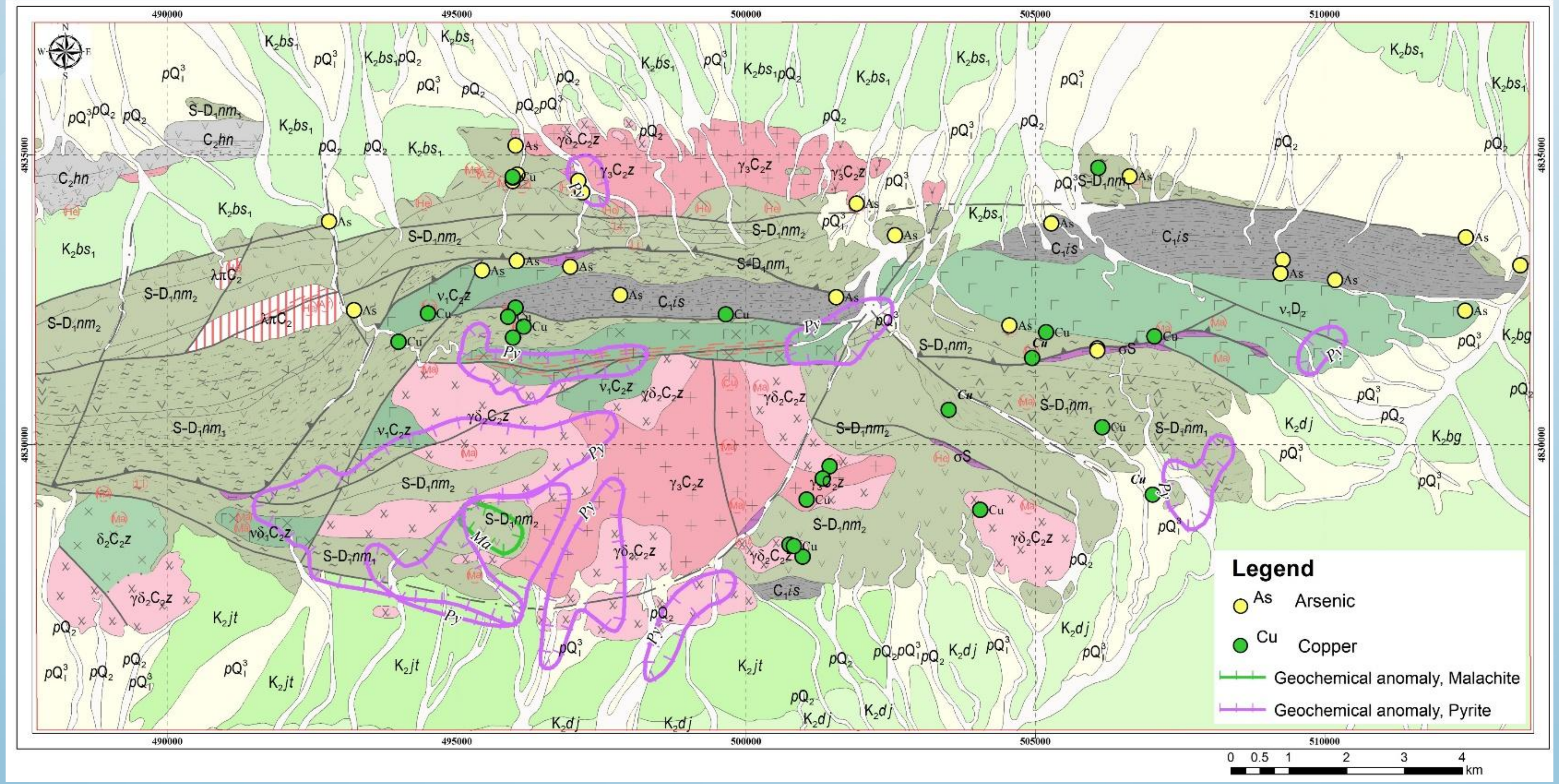
SAM-based Mapping

Integrated alteration zones



Hyperspectral mapping delineated distinct clusters of phyllic, propylitic, and argillic alteration across the study area. Their spatial relationships suggest possible structural and lithological controls, with phyllic-rich zones and overlapping alteration signatures representing priority areas for further geological investigation.

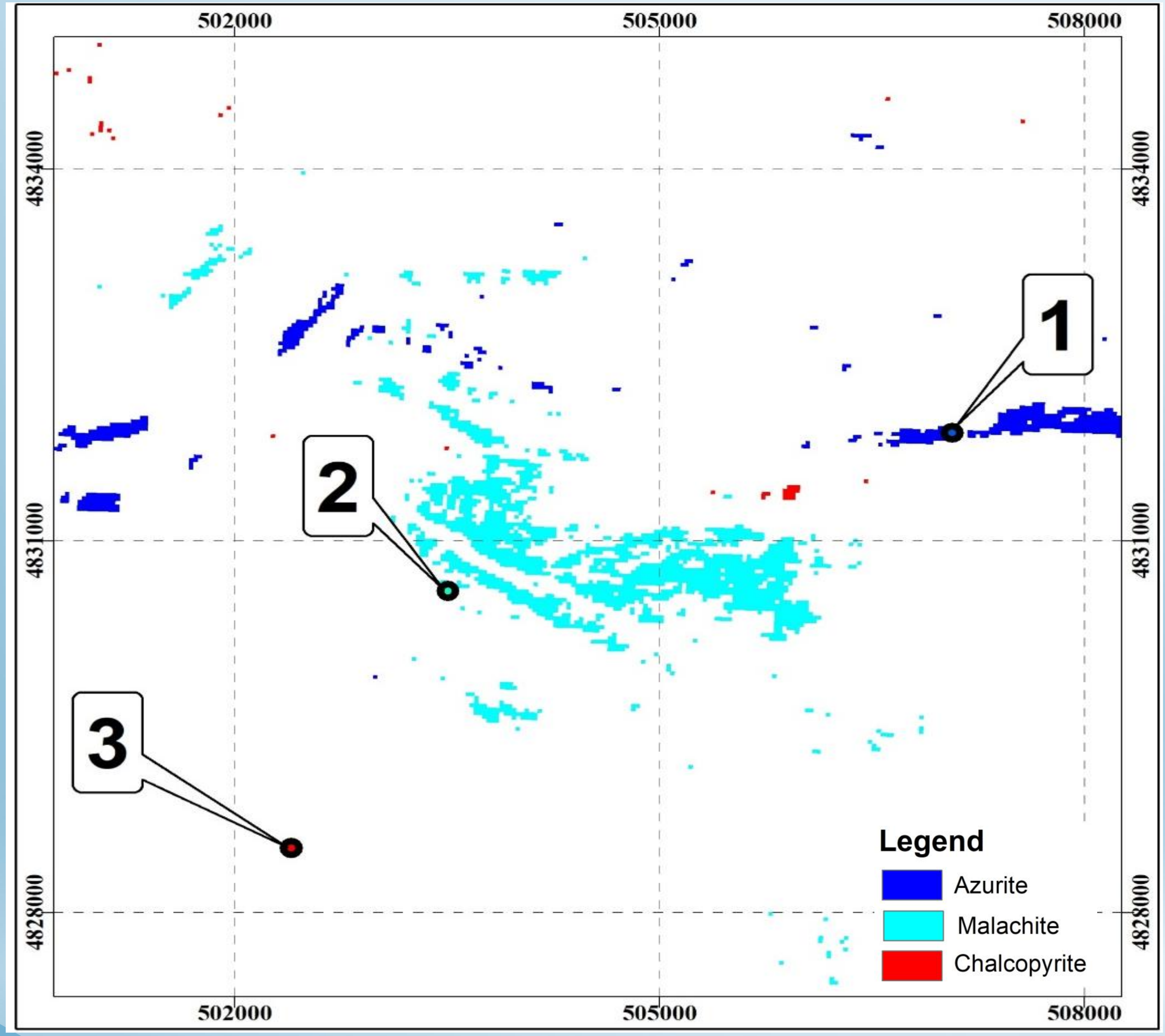
4-Training-Based Mineral and Lithological Mapping – Case Study 2



- The project area is located in Gurvantes soum, Ömnögovi Province, southern Mongolia.
- Geologically, the study area comprises sedimentary and igneous rocks ranging in age from the Carboniferous to the Quaternary.
- Previous studies identified copper, arsenic, and iron mineralization, together with associated geochemical anomalies.

Results

Spectral matching of copper minerals



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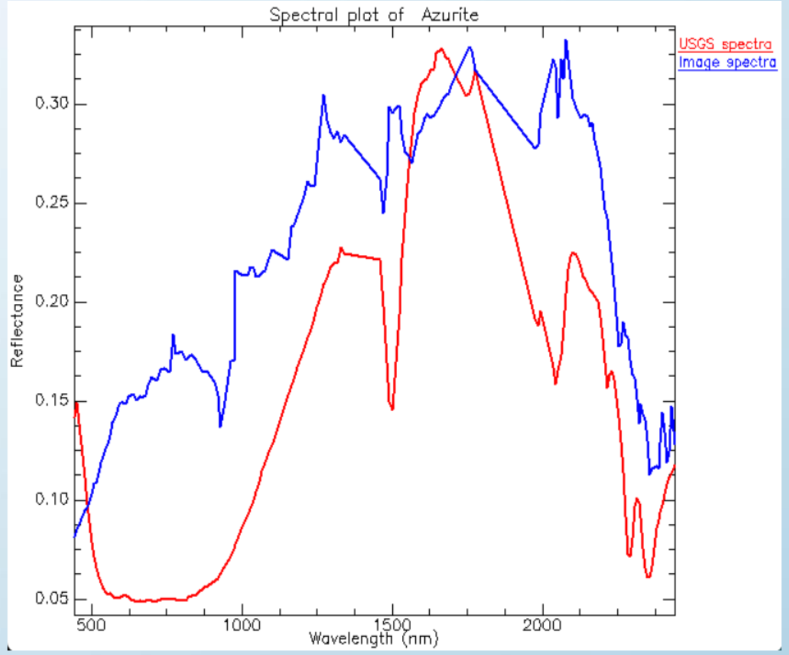

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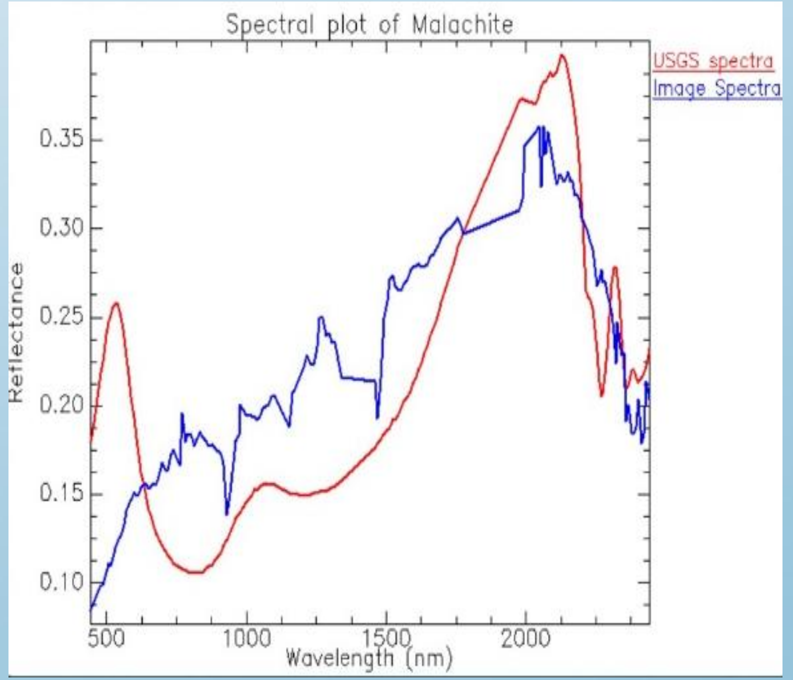

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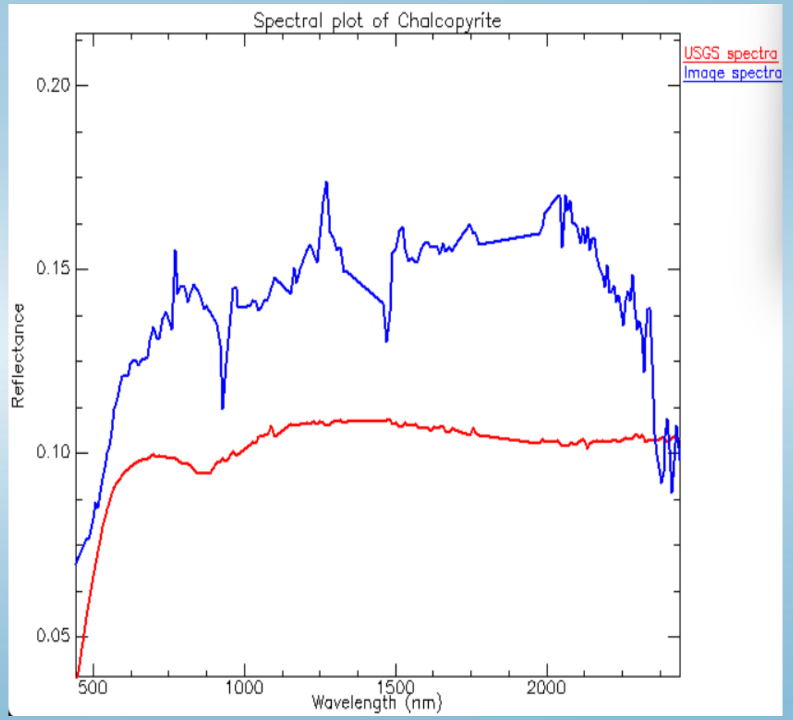
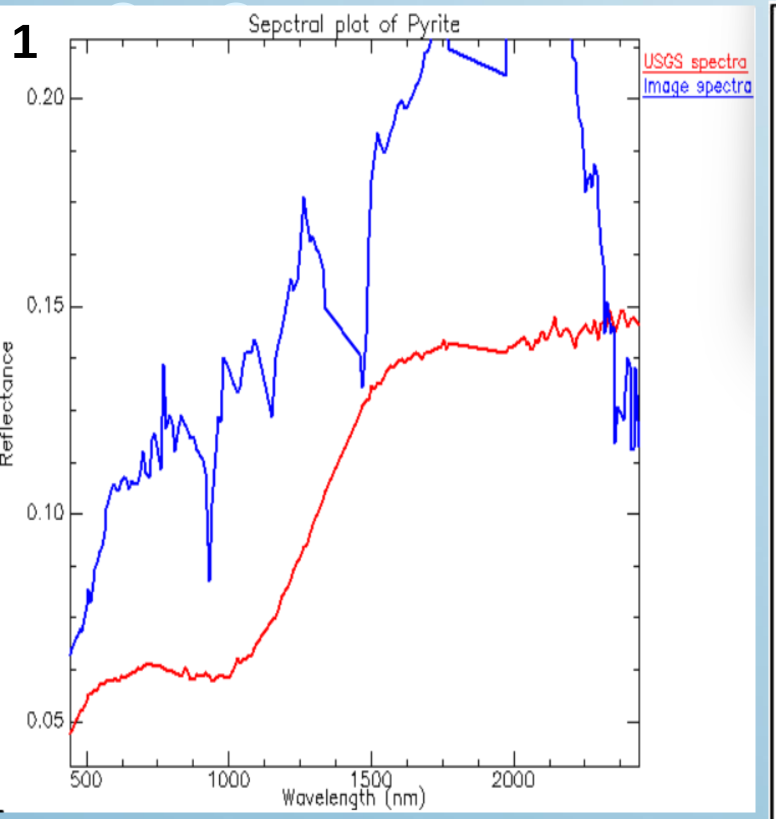
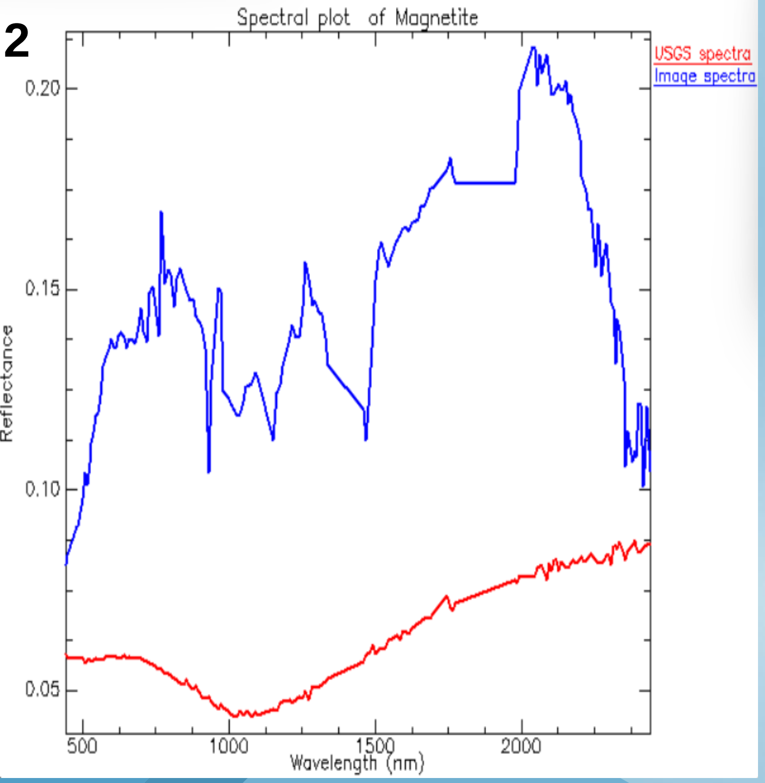
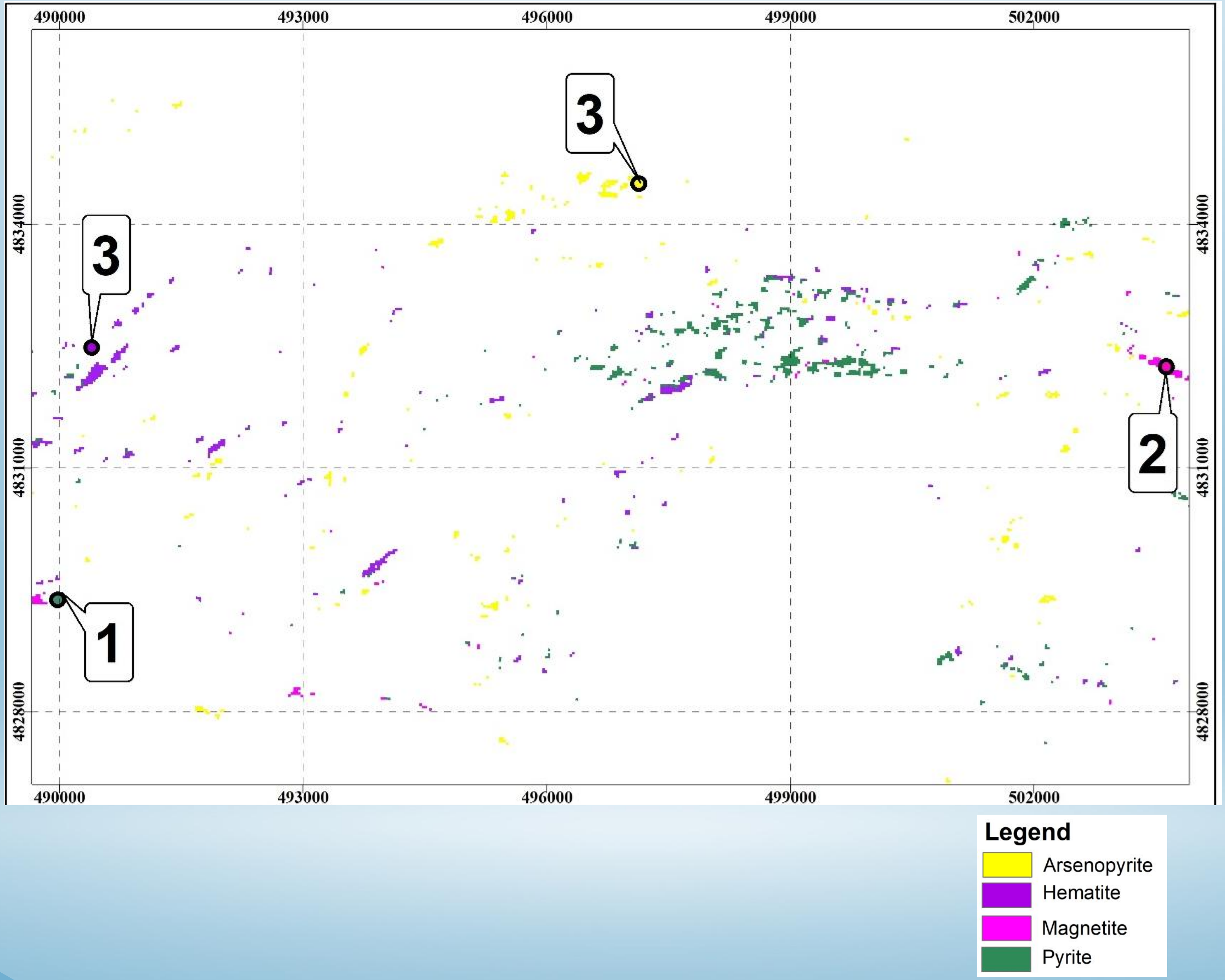


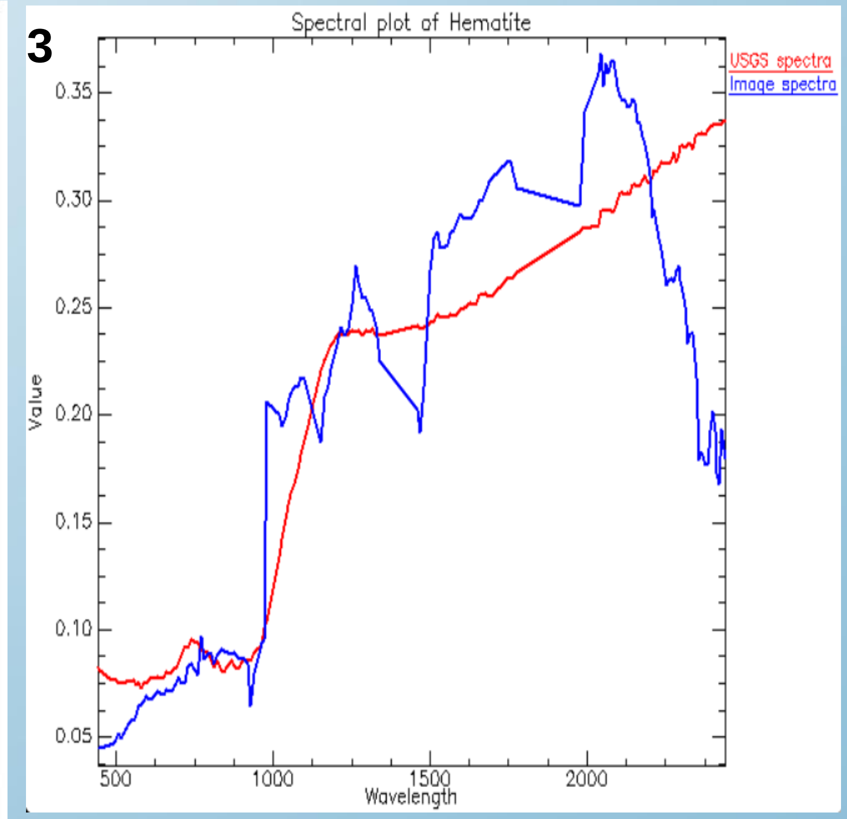
Results

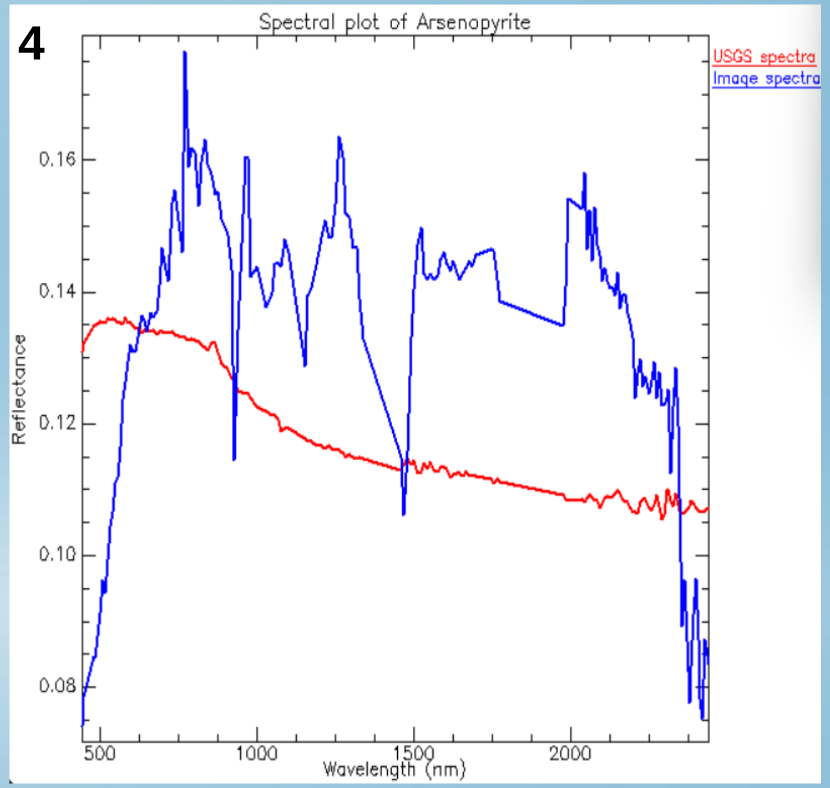
Spectral matching of copper and arsenic-bearing minerals



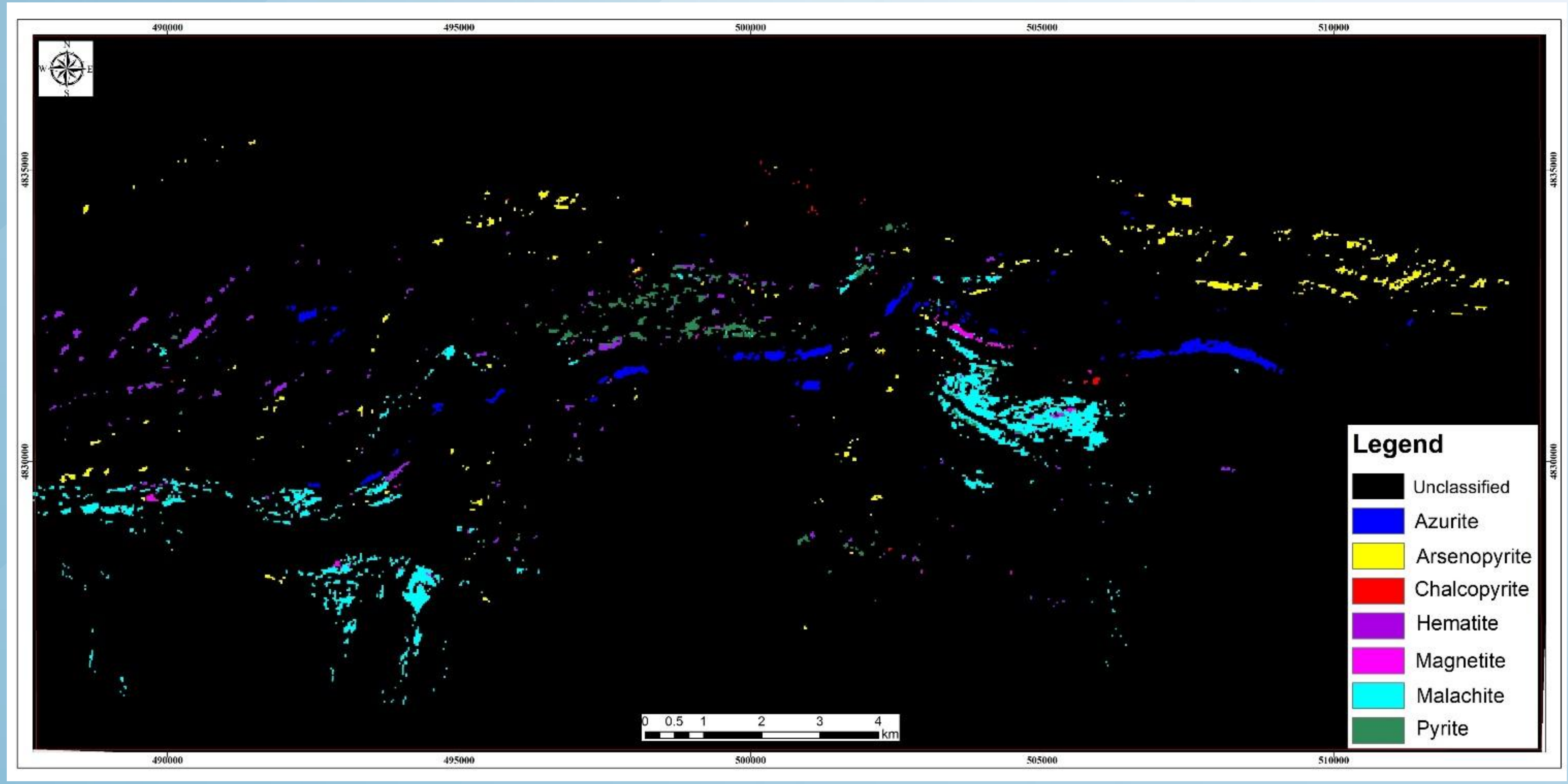






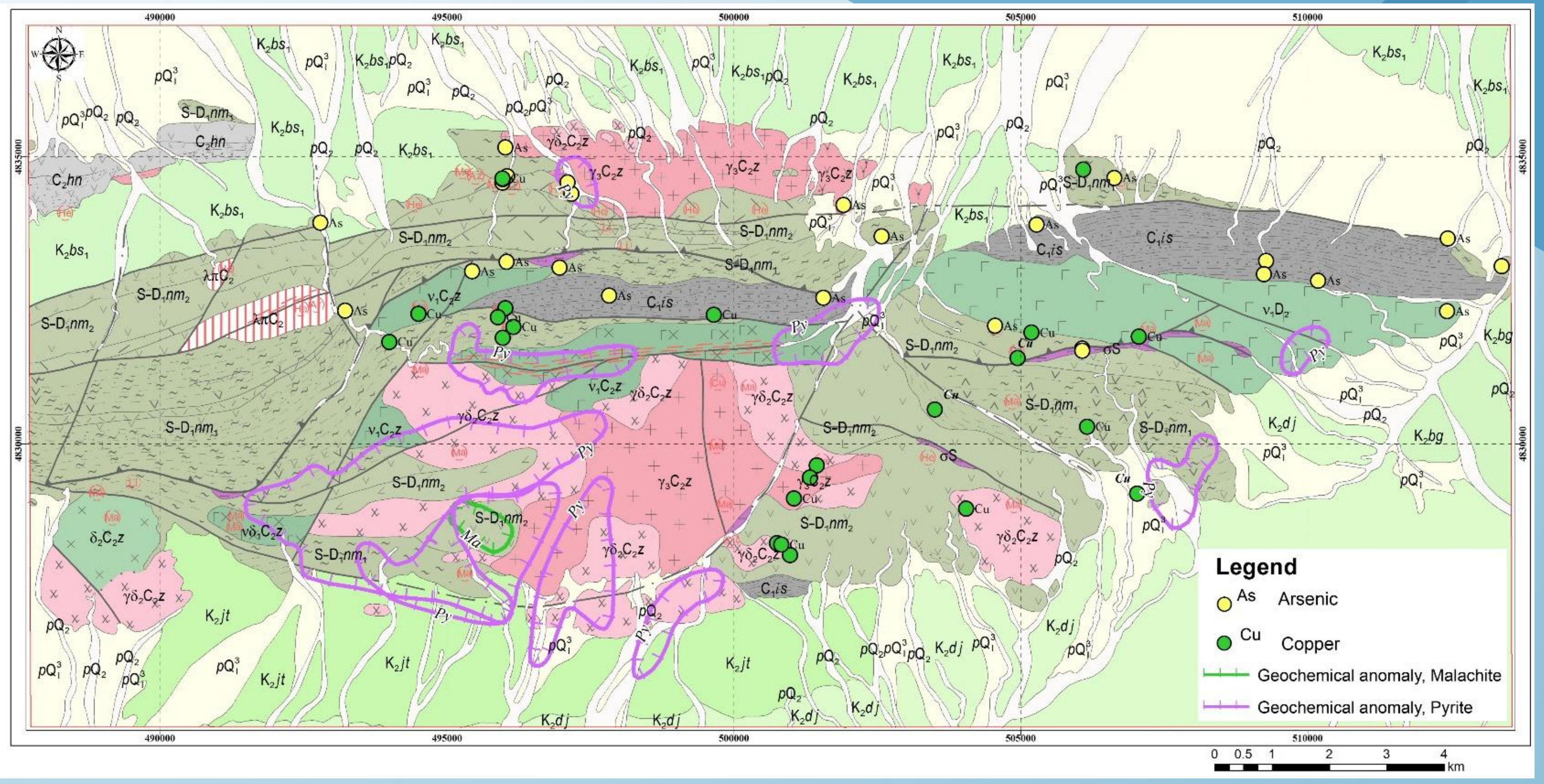


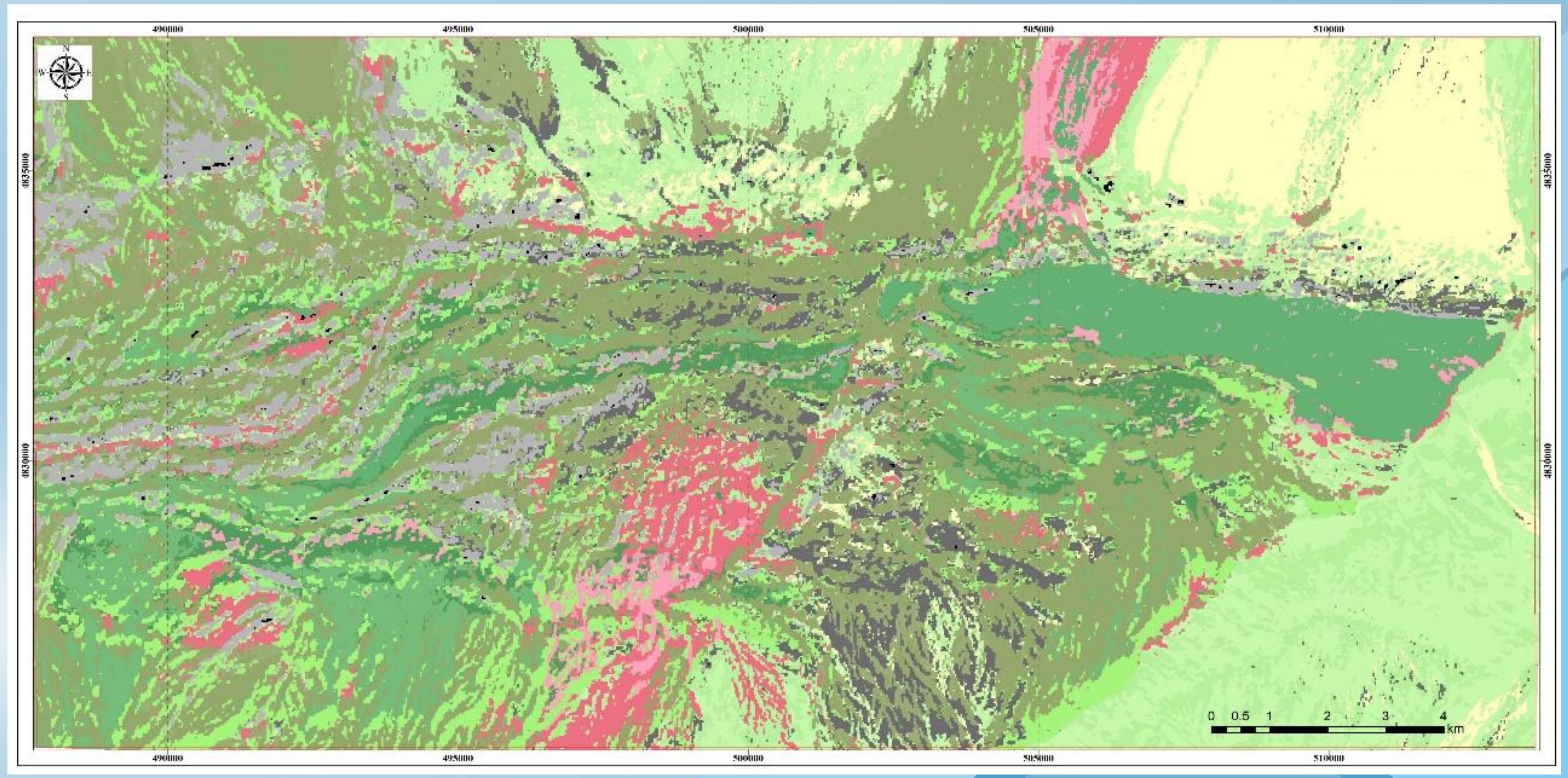
Results



Training-Based Mineral Map

Overall Accuracy = (121/127) 95.3%				
Kappa Coefficient = 0.93				
Class	Prod. Acc. (Percent)	User Acc. (Percent)	Prod. Acc. (Percent)	User Acc. (Percent)
azurite.spc A	98.39	100	61/62	61/61
arsenopy.spc	100	100	10/10	10/10
chalpy1.spc C	100	100	1/1	1/1
hematit7.spc	100	100	21/21	21/21
malachit.spc	37.5	100	3/8	3/3
pyrite5.spc P	100	100	4/4	4/4
magneti1.spc	100	87.5	21/21	21/24





Training-Based Lithological Map

5. Conclusions

- PRISMA imagery delineated spectral patterns associated with iron oxides, clay-bearing minerals, and selected mineral indicators in both study areas.
- Reference-based mapping identified candidate mineral anomalies using USGS spectra and SAM.
- Training-based mapping supported broader mineral and lithological interpretation.
- The results define preliminary exploration targets that require field, spectral, and geochemical verification.

✓ Recommended next step: Integrate PRISMA hyperspectral imagery with radiometric survey data to improve the accuracy and reliability of lithological mapping, supported by field observations and geochemical data.

References

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Thank you for your attention